



Cisco Expo
2009

NGN Transport Solutions



Cisco Expo Maroc, 30 juin / 1^{er} juillet 2009

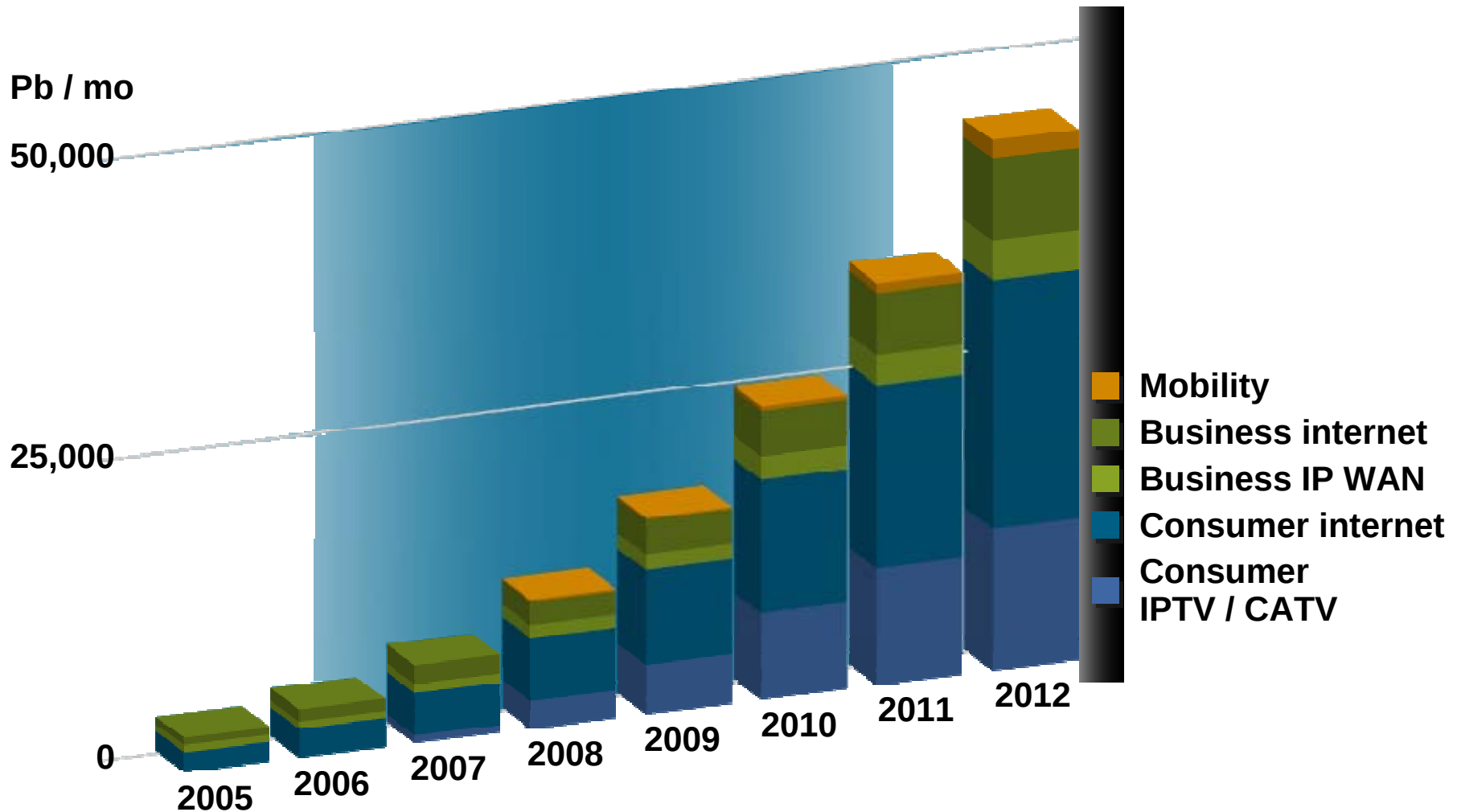
Louis-Vincent Perrinel – Consulting System Engineer

Agenda

1. Service Provider Network Evolution Background
2. IPoDWDM Solutions
3. Scaling Bandwidth: per-channel 40G, 100G and beyond
4. Enhancing Agility: towards the Zero-Touch Network
5. References

Global IP Traffic Growth

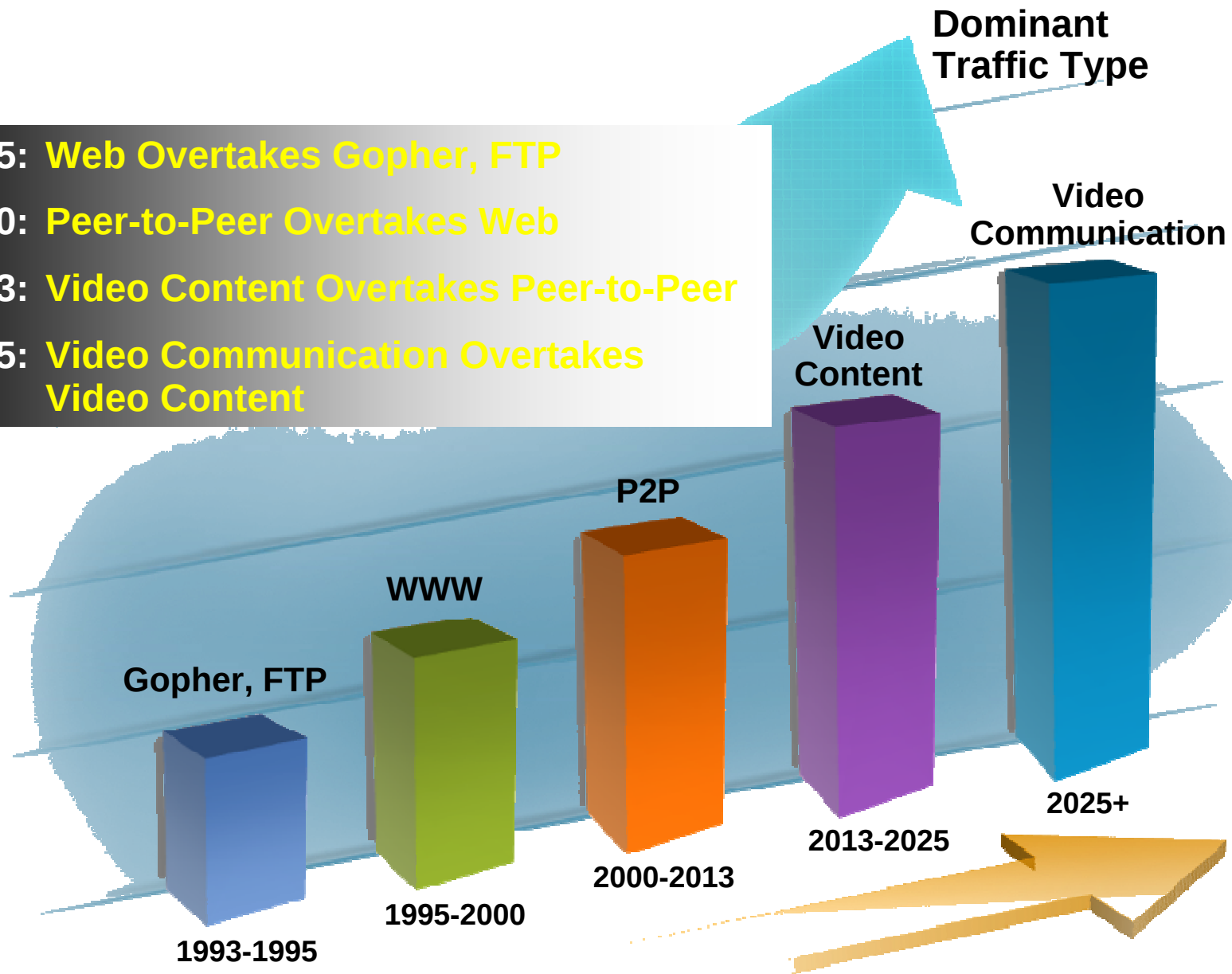
Internet in 2012 Will Be 75x What It Was in 2002



Source: Cisco Visual Networking Index — Forecast, 2007–2012

Growth...Fueled by Video

1995: **Web** Overtakes Gopher, FTP
2000: **Peer-to-Peer** Overtakes Web
2013: **Video Content** Overtakes Peer-to-Peer
2025: **Video Communication** Overtakes Video Content



Industry Trends: Service Provider



Economic Pressure on SP Spending

- Traffic increasing capex faster than revenue growth
- Profitable models for IP / MPLS investment



Video over IP Network Growth

- SP offerings: new profit opportunities
- specialized offerings: need shared business model



Mobile Internet Acceleration

- New radios delivering broadband IP
- Developed markets: Mobile supplanting fixed
- Emerging markets: Mobile only choice

Network “Table Stakes”



Optical / IP Integration

- IP+WDM key from metro to core applications
- Network Architecture approach saves OpEx & CapEx



Evolved Transport Layer

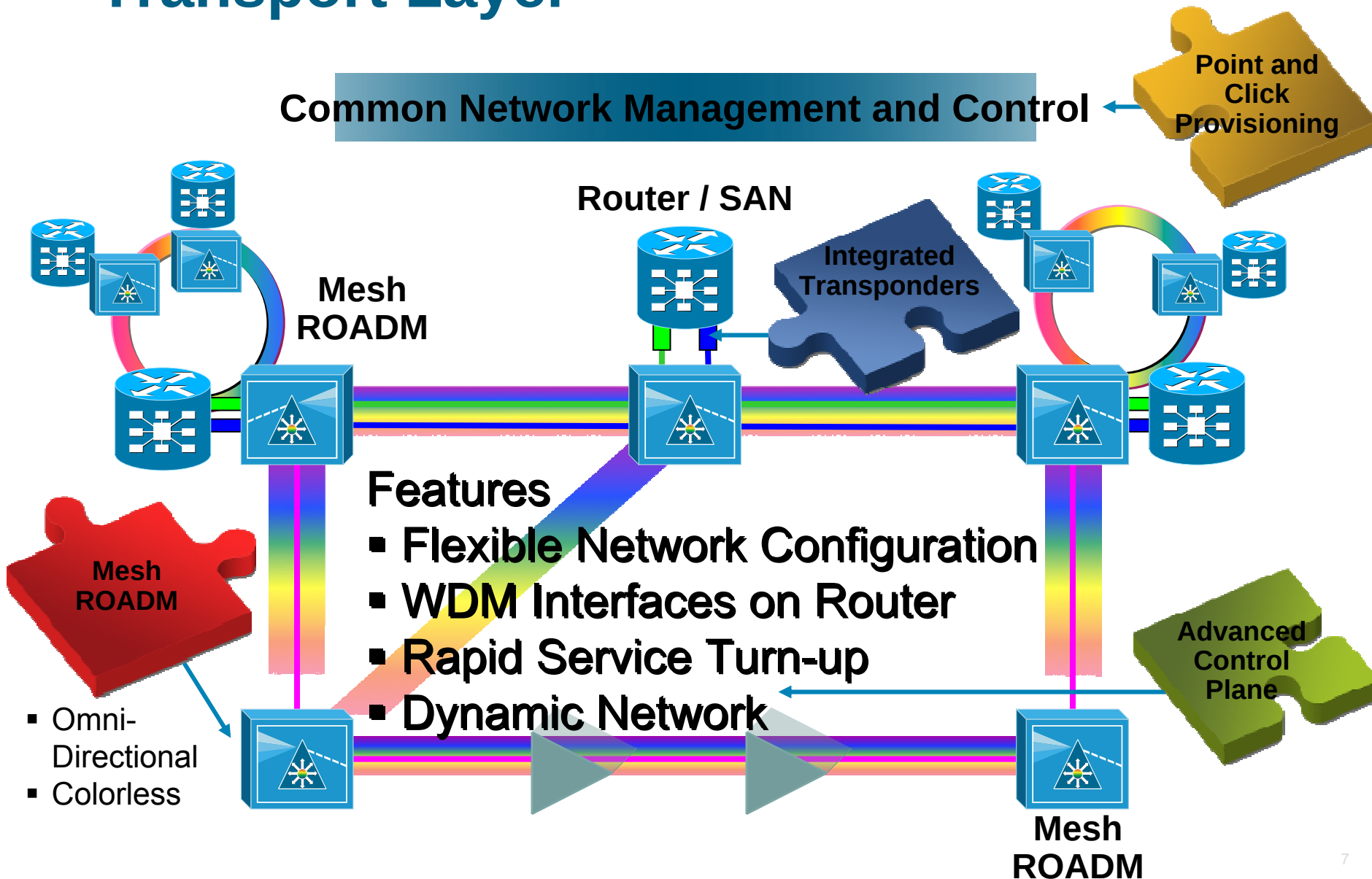
- ROADM has redefined transport layer
- MSTP Platform must scale from Edge to Core applications



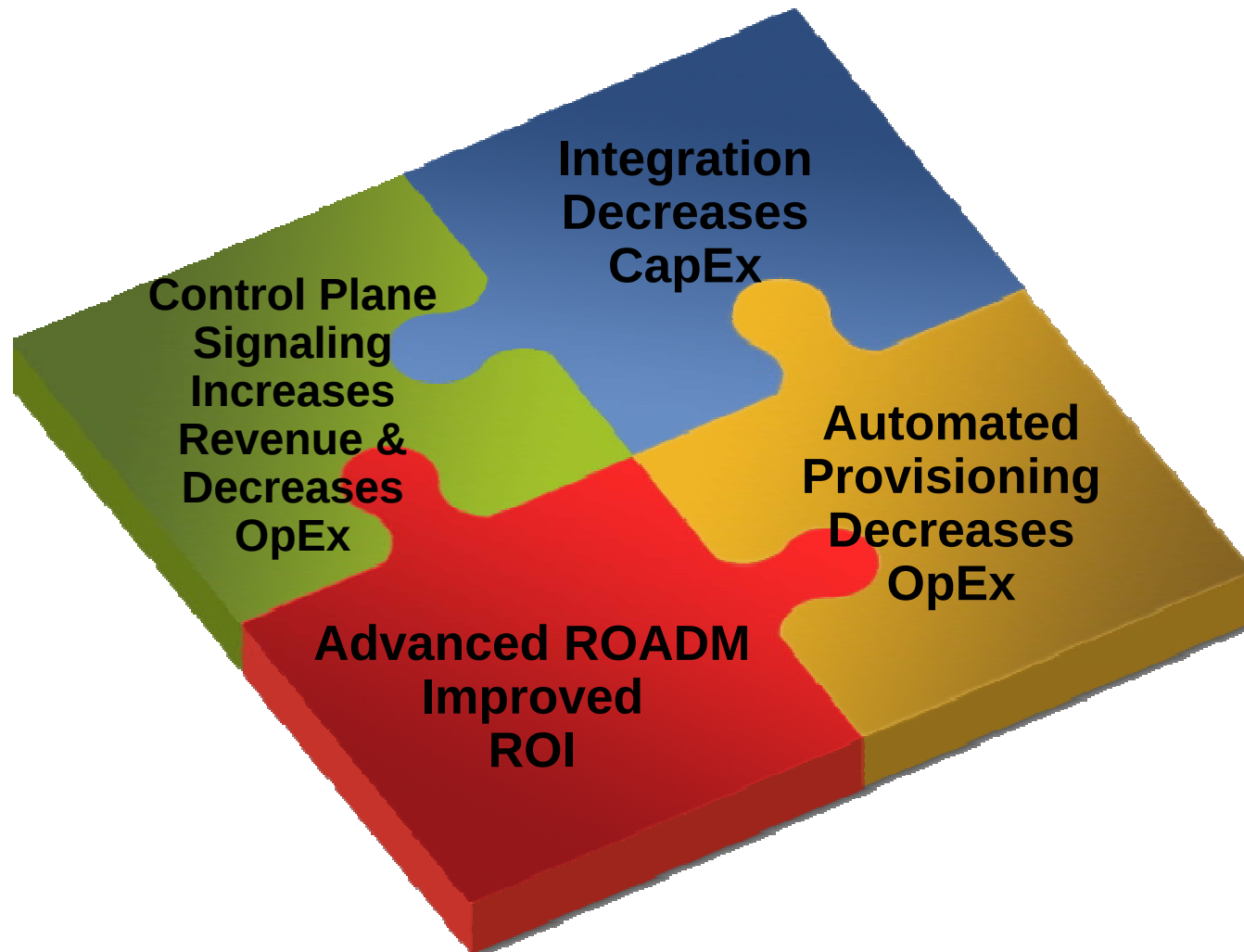
Service Integration

- MPLS will play an expanding role in handling customer requirements across all applications

IP NGN Convergence — Transport Layer



Economic Benefits



Agenda

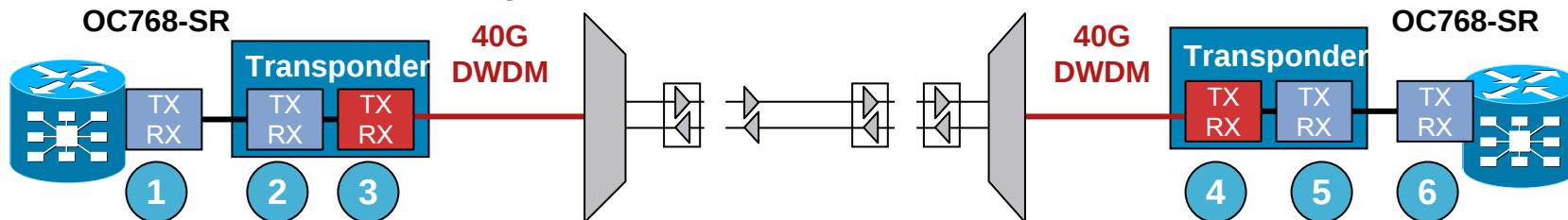
1. Service Provider Network Evolution Background
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What Is IPoDWDM?

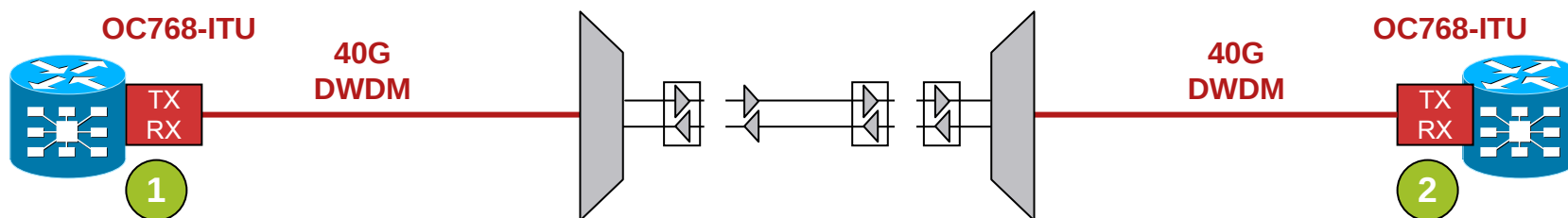
1. IPoDWDM is a new network model which integrates the Transponder within the Router Blade
2. This reduces both Cap as well as OP Ex while increasing network scalability, flexibility and time to market
3. Integration of the DWDM transponder onto the Router blade allows for a robust, intelligent network

Why IPoDWDM

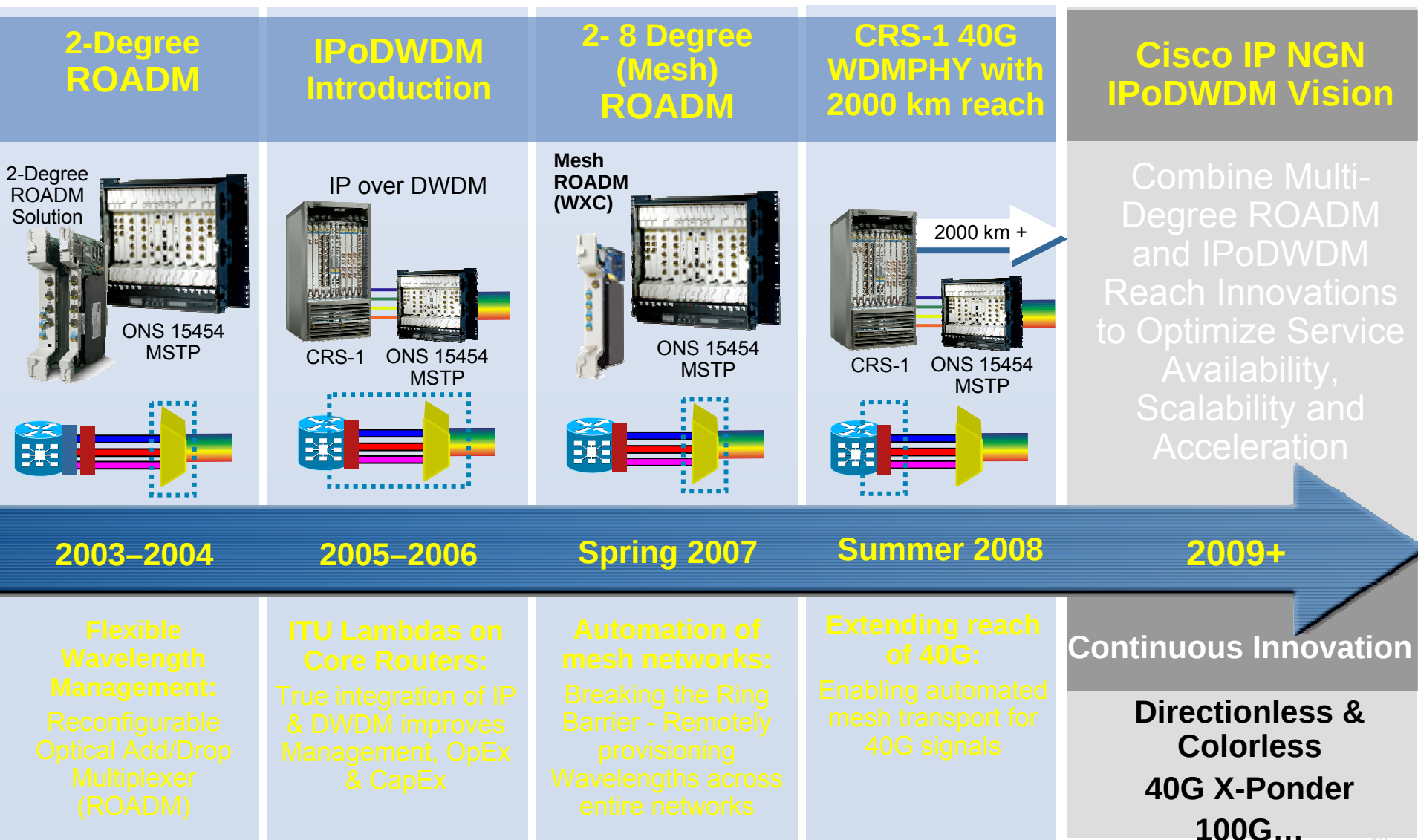
Traditional Model: External Transponder



Next Gen.: IPoDWDM



IPoDWDM leadership – More than the Sum of its Optical & IP parts

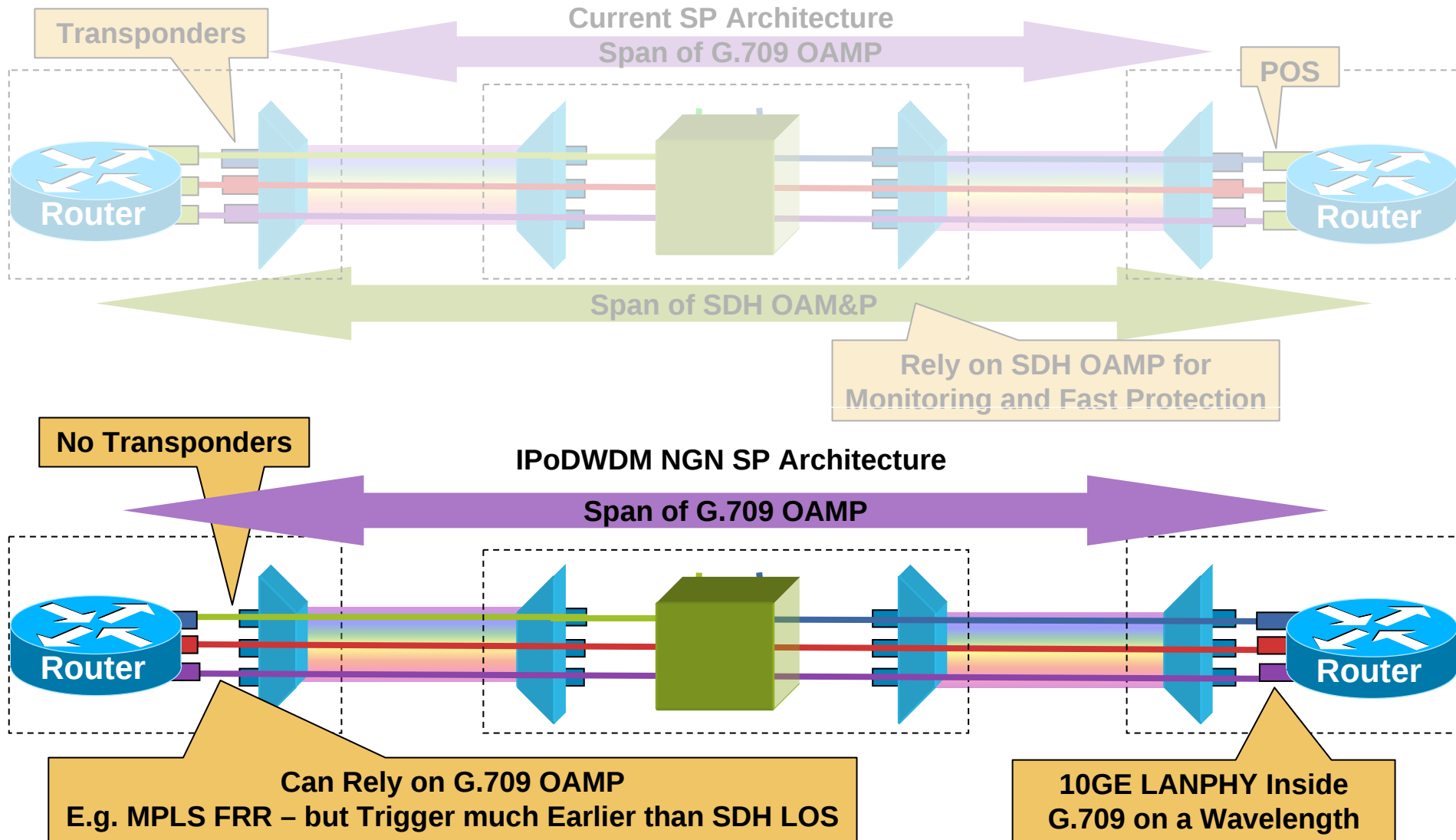


Cisco Variety of IPoDWDM Interfaces

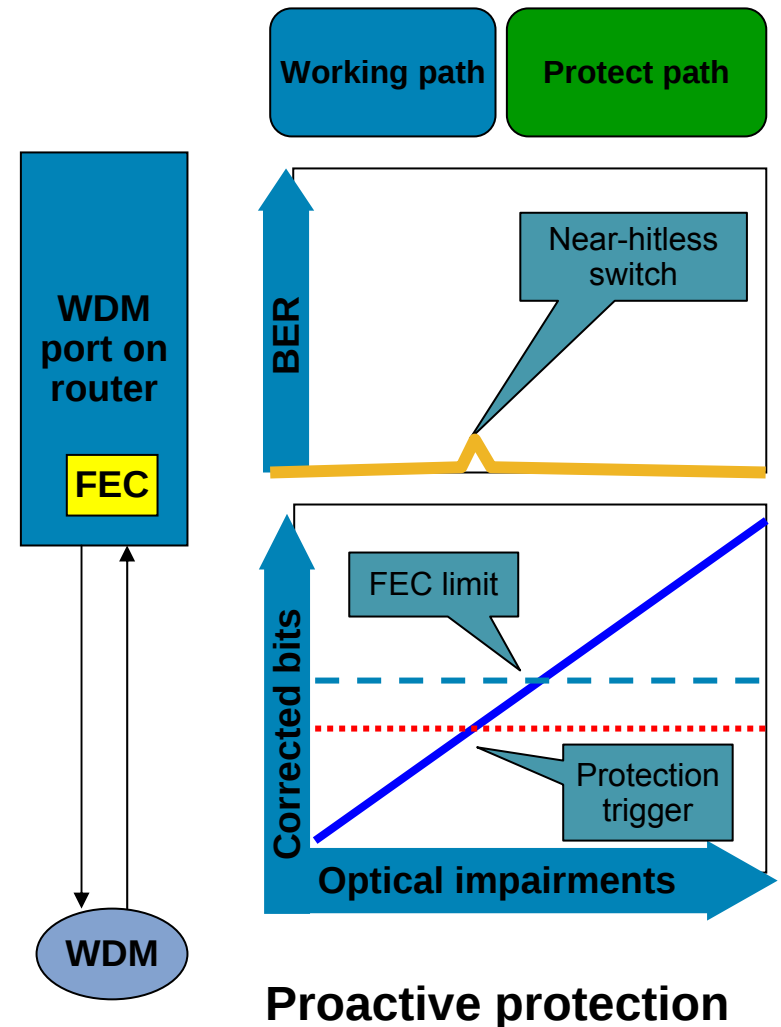
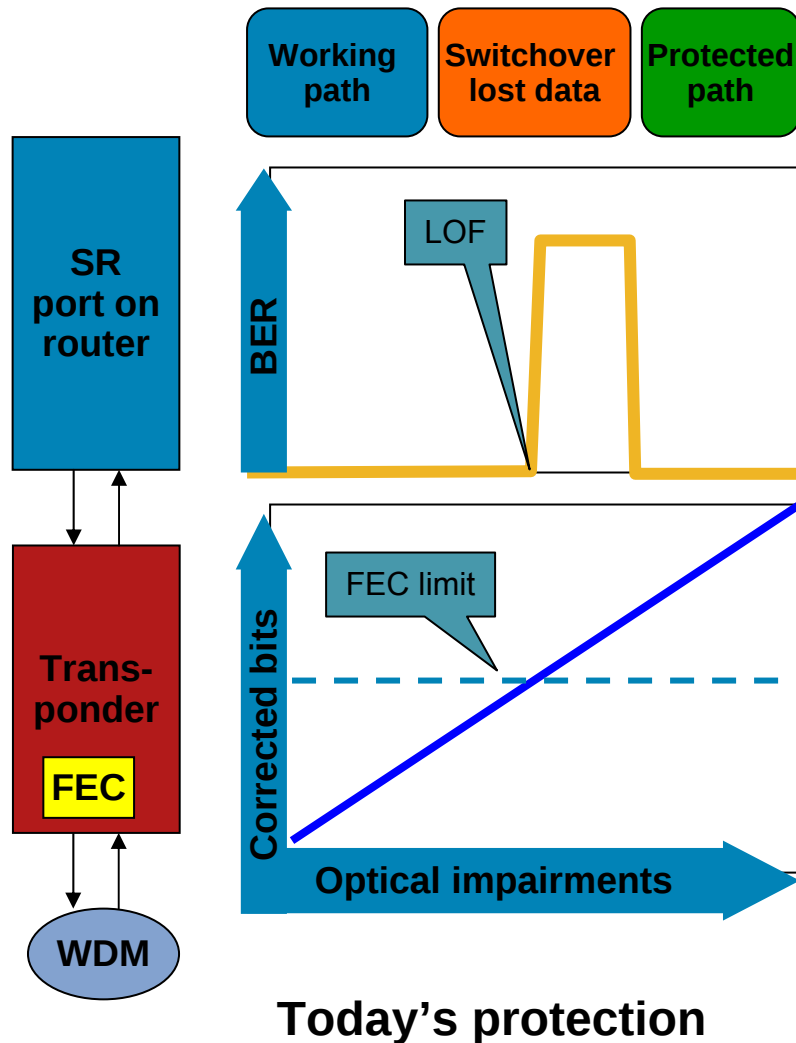
1. Cisco CRS-1 1-Port OC-768C/STM-256C Tunable WDMPOS.
2. Cisco CRS-1 1-Port OC-768C/STM-256C DPSK+ Tunable WDMPOS Interface Module.
3. Cisco CRS-1 4-Port 10GE Tunable WDMPHY Interface Module.
4. Cisco 1-Port 10 Gigabit Ethernet (10GE) Tunable WDM-PHY Shared Port Adapter on the Cisco 12000 and CRS-1
5. Cisco 2-Ports and 4-Ports 10 Gigabit Ethernet (10GE) with G.709 on the Cisco 7600 using XFPs.
6. Tunable XFPs on MSTP (Q3 2009)

Intelligent Transport Layer

G.709 OAMP Functionality



Proactive FRR based on pre-FEC errors

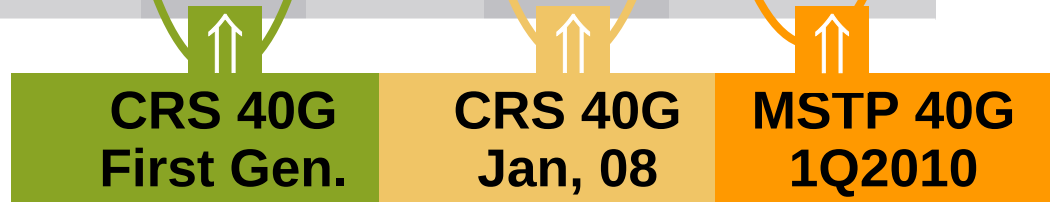


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Improved 40G Optical Performance

Parameter	NRZ	ODB	DPSK	DPSK+	DQPSK
50 GHz Compatible	N	Y	N	Y	Y
Worst Case Reach (km)*	500	500	>1000	>1000	~1000
Chromatic Dispersion Robustness (ps/nm)	+/- 50	+/- 150	+/- 50	+/- 650	+/- 650
PMD Robustness (ps)	2.5	2-3	2.5	2.5-3.5	5-8
Complexity	Med	Med	Med+	Med +	High



* Distance depends on link specifics. 2x worst case is possible.

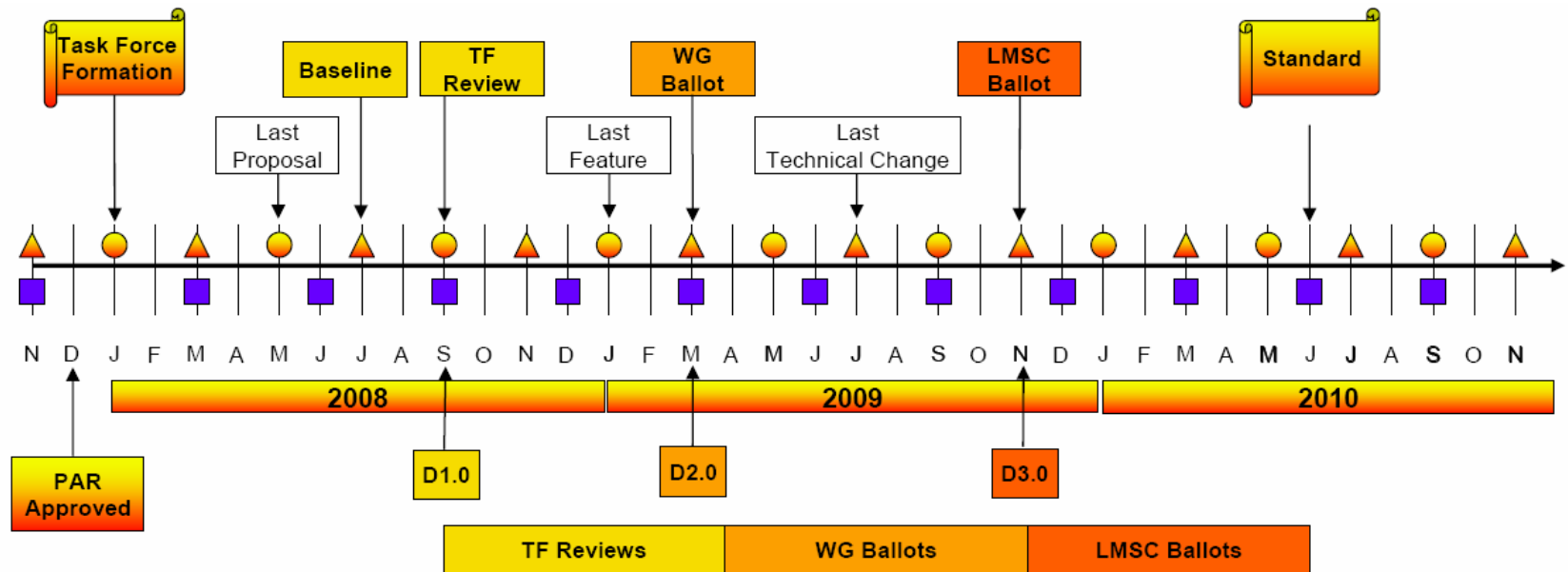
* Additional reach (~2x) possible with Raman amplification

100Gig E in the IEEE

802.3ba Objectives

- Support full-duplex operation only
- Preserve the 802.3 / Ethernet frame format utilizing the 802.3 MAC
- Preserve minimum and maximum FrameSize of current 802.3 standard
- Support a BER better than or equal to 10^{-12} at the MAC/PLS service interface
- Provide appropriate support for OTN
- Support a MAC data rate of 40 Gb/s
 - Provide Physical Layer specifications which support: 40 Gb/s
 - at least 100m on OM3 MMF
 - at least 10m over a copper cable assembly
 - at least 1m over a backplane
- Support a MAC data rate of 100 Gb/s
- Provide Physical Layer specifications which support:
 - at least 40km on SMF
 - at least 10km on SMF (likely to become 2-4km)
 - at least 100m on OM3 MMF
 - at least 10m over a copper cable assembly

IEEE 802.3ba Timeline



100GE and the ITU

1. ITU agreed to optimize new OTU4 rate for 100GE transport
2. Industry appears to have learnt its lesson from 10GE (i.e. LAN/WAN PHY)

Ideally want one mapping, one FEC and one modulation scheme !!!
some resistance from traditional transport vendors

3. Transmission requirements are the same as 40G:

Must work over existing, installed DWDM common equipment;

Support 50GHz DWDM channel spacing;

Full band tunable lasers on 50GHz ITU grid

Optical reach of $\geq 1,500\text{km}$;

Chromatic dispersion tolerance of $>\pm 800\text{ps/nm}$;

Polarization Mode Dispersion tolerance of $> 10\text{ps}$ (mean DGD);

Must be “plug and play” and installable by existing field technicians

4. 40G was the first commercial application for advanced modulation:

100G will build on similar approaches

100G Development Efforts

1. Leading standardization effort within OIF (eco-system)

Strong supplier base and supply continuity (multiple vendor soln)

Compatibility among system vendors

Share development costs and reduce risks

2. Structure/architecture of the solution

Separate cards for client and trunk

Regenerator uses 2 trunk cards

3. Target Data rates / standards supported

OTU4 trunk as per ITU-T G.709 standard

Multiplexing of 10x10G (10GE, OC192, FC-1200, OTU2)

Multiplexing of 2x40G (OC768, 40GE, OTU3) plus 2x10G (10GE, OC192, FC-1200, OTU2)

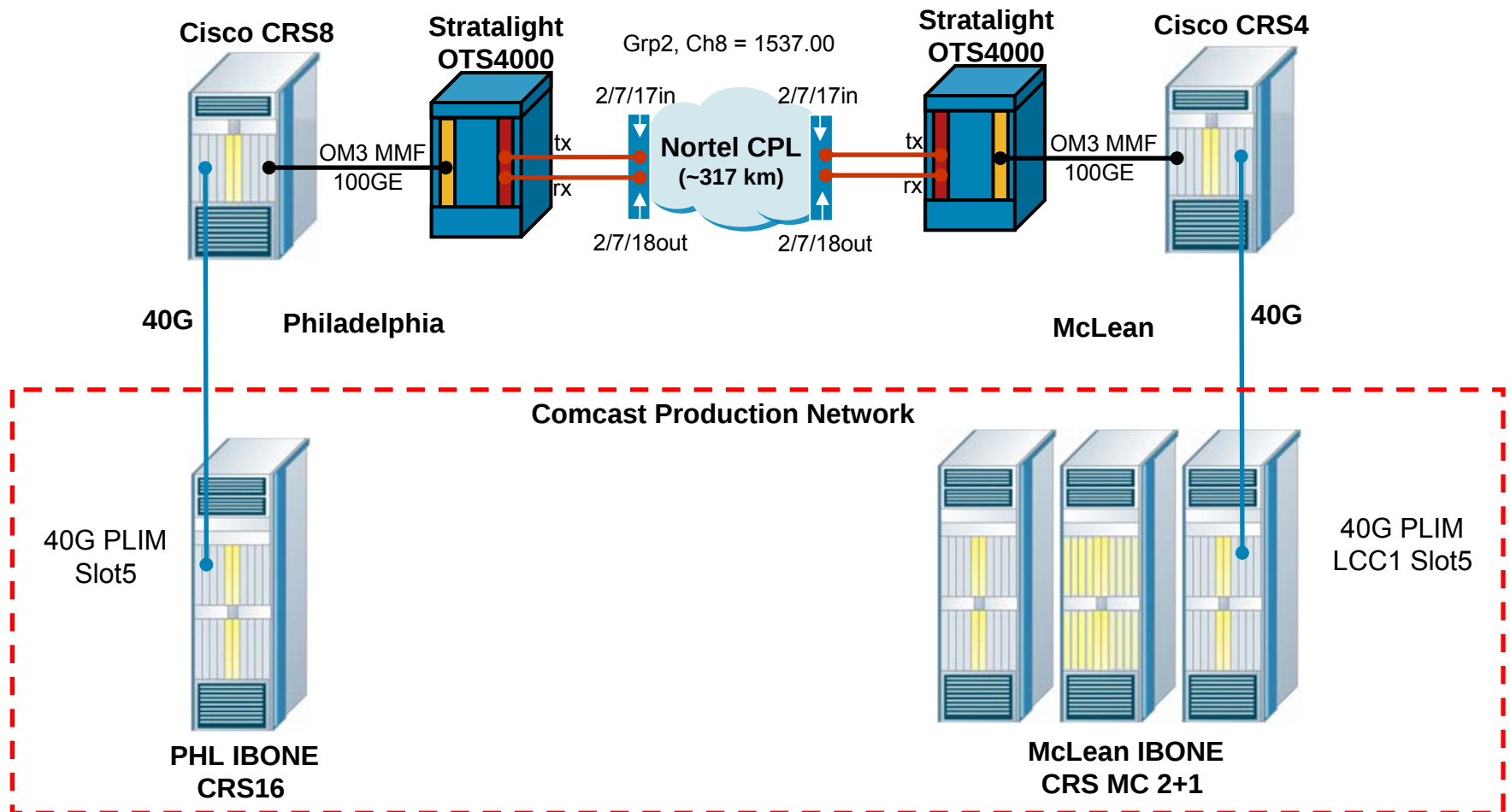
100GE Native

Cisco 100GbE demo – June08

1. Cisco demonstrated world's first operational 100GbE MAC and router interface
2. Demo included DWDM transmission over production network in Comcast's network
3. 100GbE MAC was based on Cisco's MLD architecture which is baseline for IEEE 802.3ba
 - implemented in FPGA
 - very robust architecture

Cisco 100GbE demo – June08

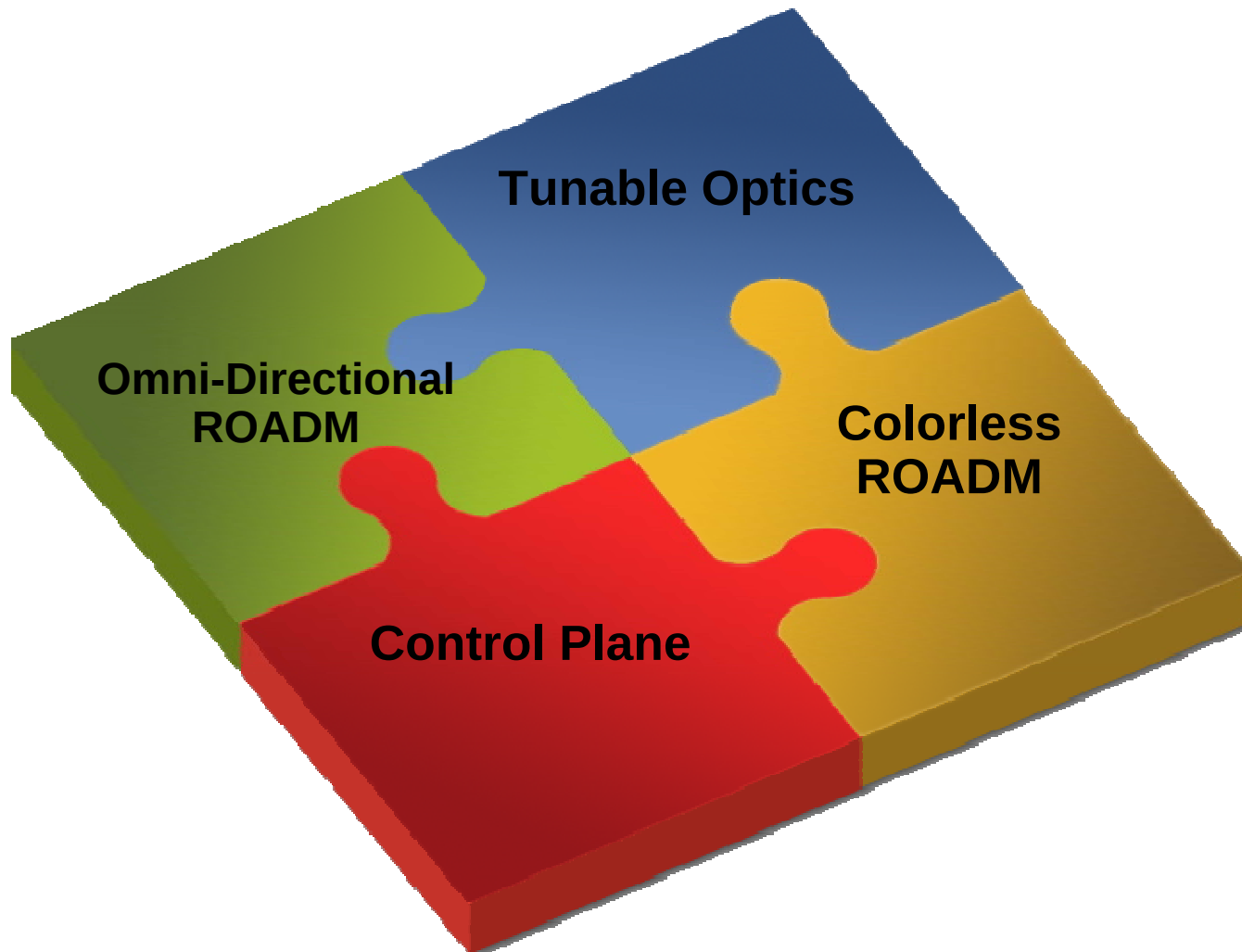
100GE DEMO Network



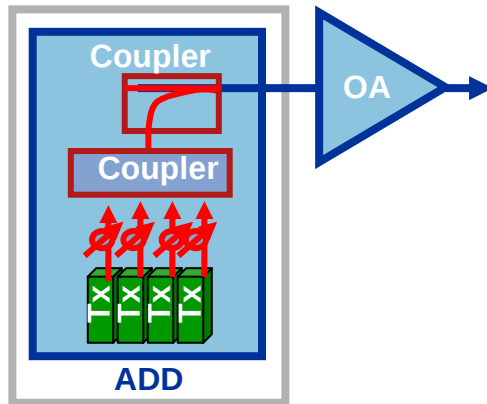
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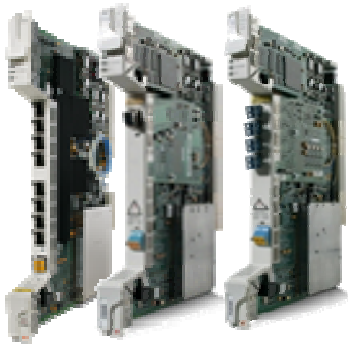
Putting the Pieces of the Zero-Touch DWDM Network Together



Tunable Optics



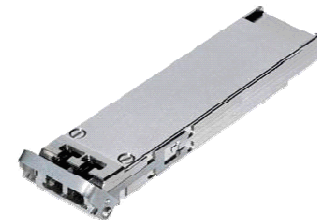
- Full C-band Tunable
- 50GHz Stable
- G.709/FEC/EFEC Enabled
- 10Gb, 40Gb, 100Gb



TxP/MxP/XP

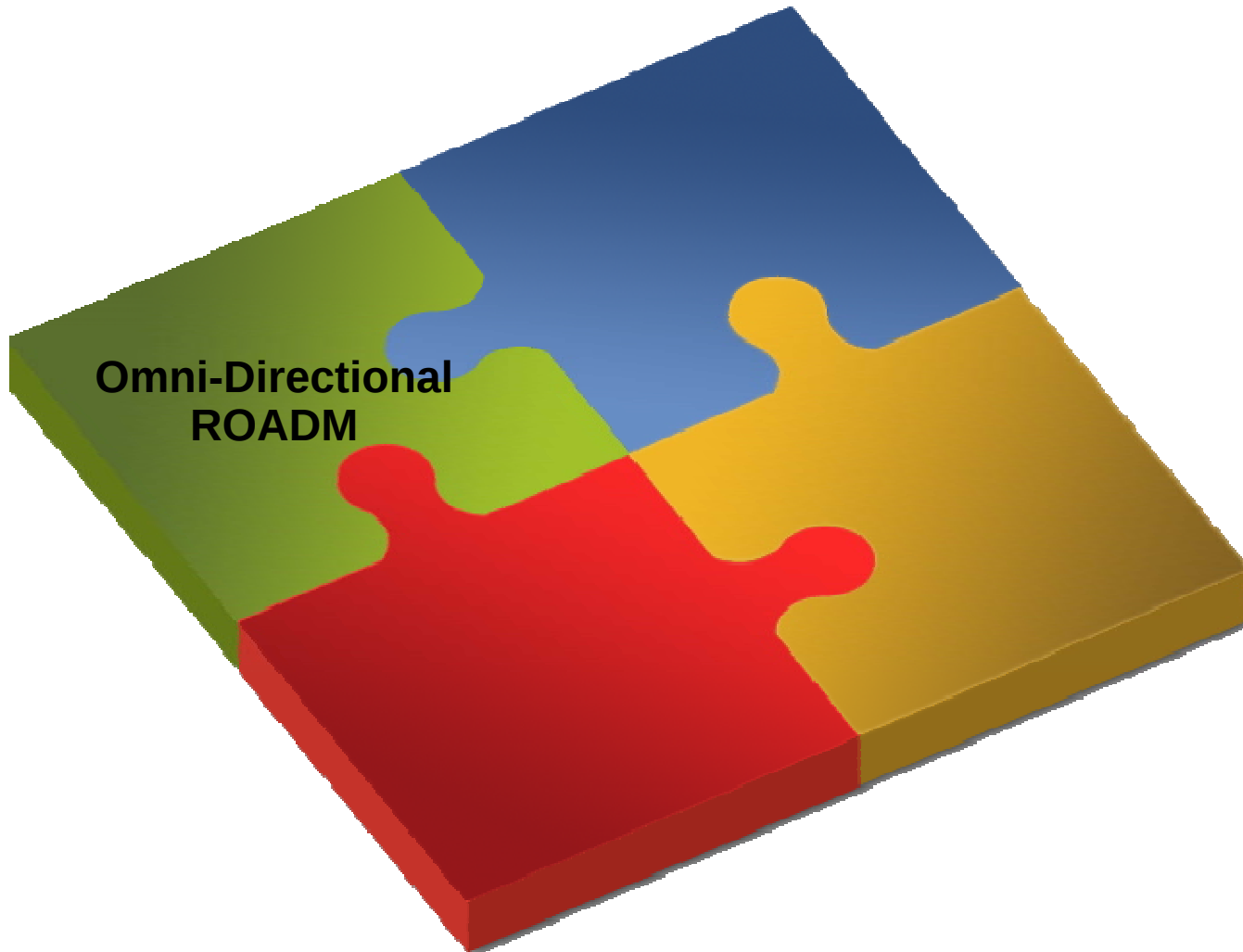


Router ITU Optics



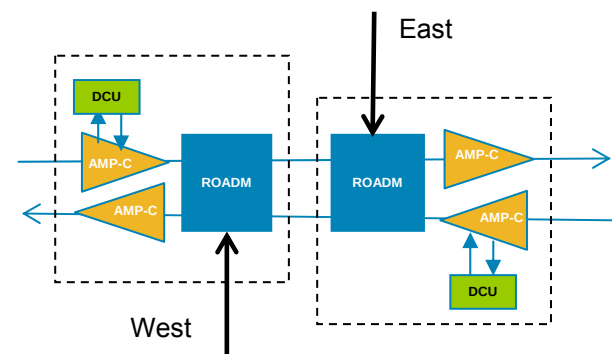
Tunable XFP

Putting the Pieces of the Zero-Touch DWDM Network Together

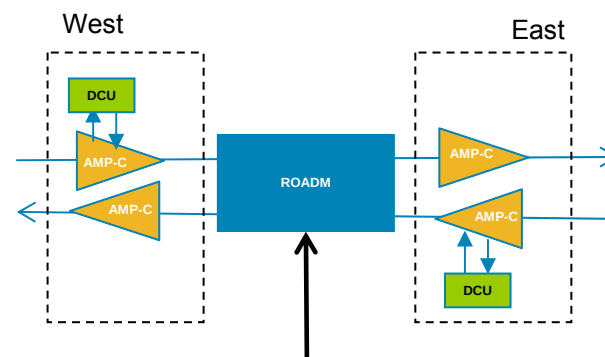


Directional and Omni-Directional DWDM

- In an Add/Drop Node normally every channel is **tied to a direction**
 - Adding a channel West requires to plug the DWDM interface into the West-facing ROADM
 - This is applicable to both Degree-2 and Multi-Degree Nodes
- Omni-Directional capability allows the selection of the **direction for the wavelength independently**



Directional DWDM



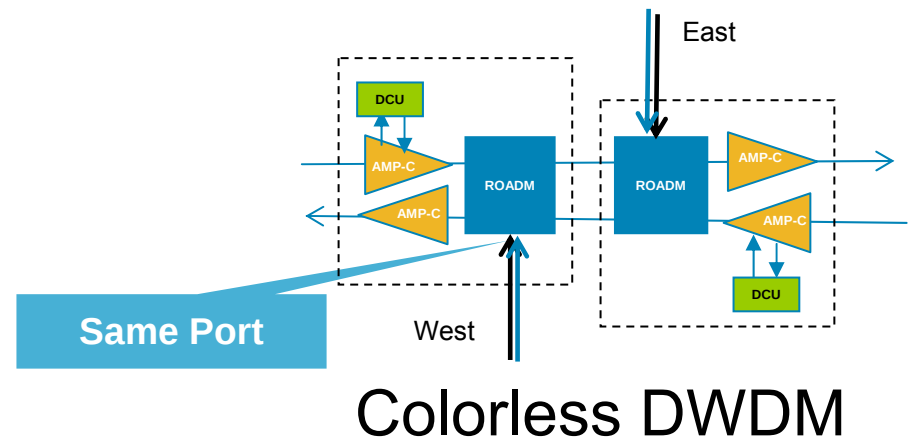
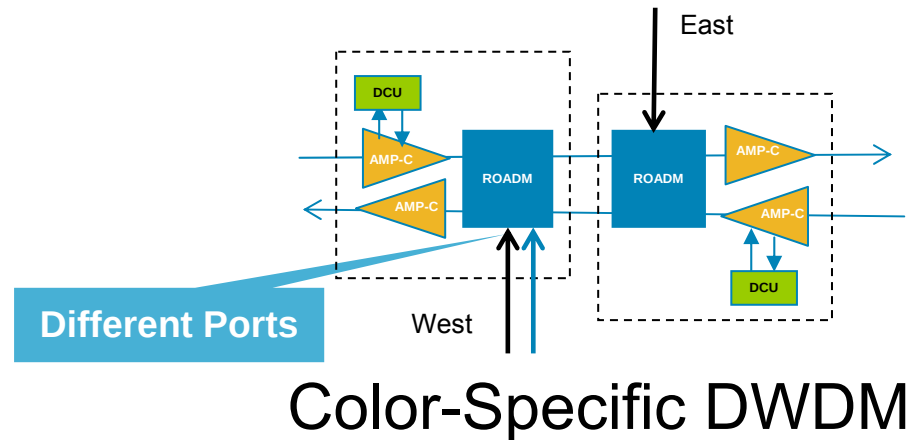
Omni-Directional DWDM

Putting the Pieces of the Zero-Touch DWDM Network Together



Colored and Colorless ROADMs

1. Currently every channel is tied to a specific port on the filters
2. Only channel 1 can work on Port 1 / Only channel 2 can work on Port 2
3. Colorless allows use of different wavelengths for different sections of optical path to avoid congestion



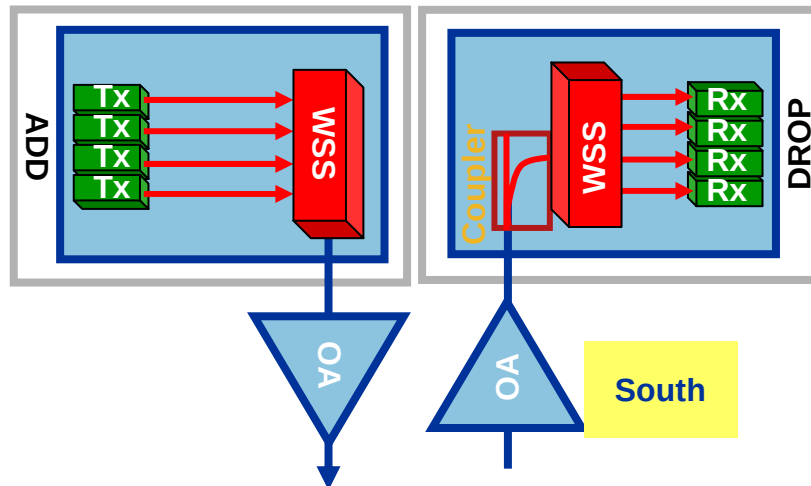
Colorless Multi-Degree Mux and Demux WSS

1. Supports any wavelength from any degree to any degree
2. Drop port count limitations due to port sharing with inter-degree connections
3. Add/drop ports are colorless

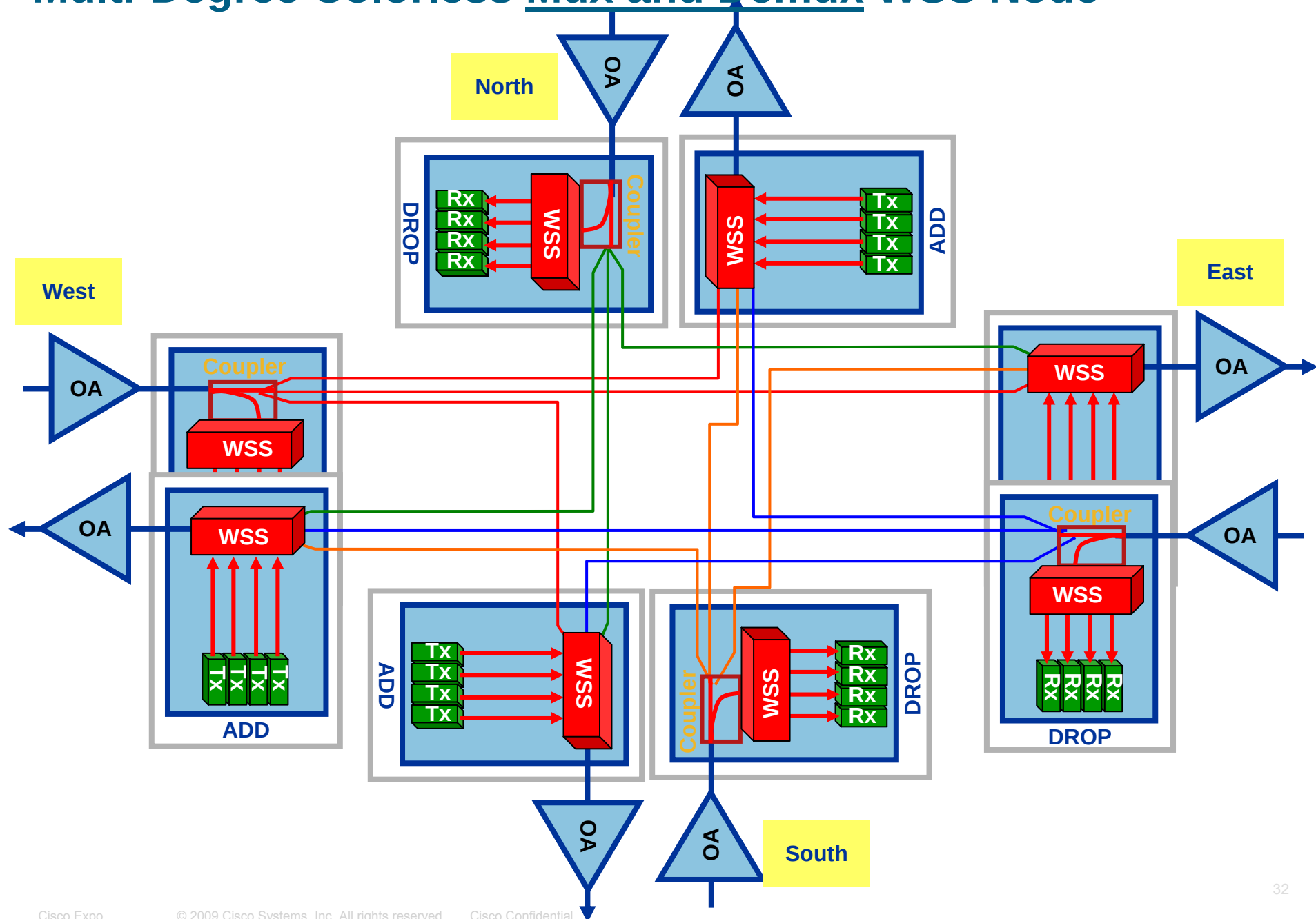
Add port filtering rejects rogue wavelengths and noise

4. Supports drop and continue
5. Add and express channel equalization provided by Mux WSS

Demux WSS provides drop channel power control



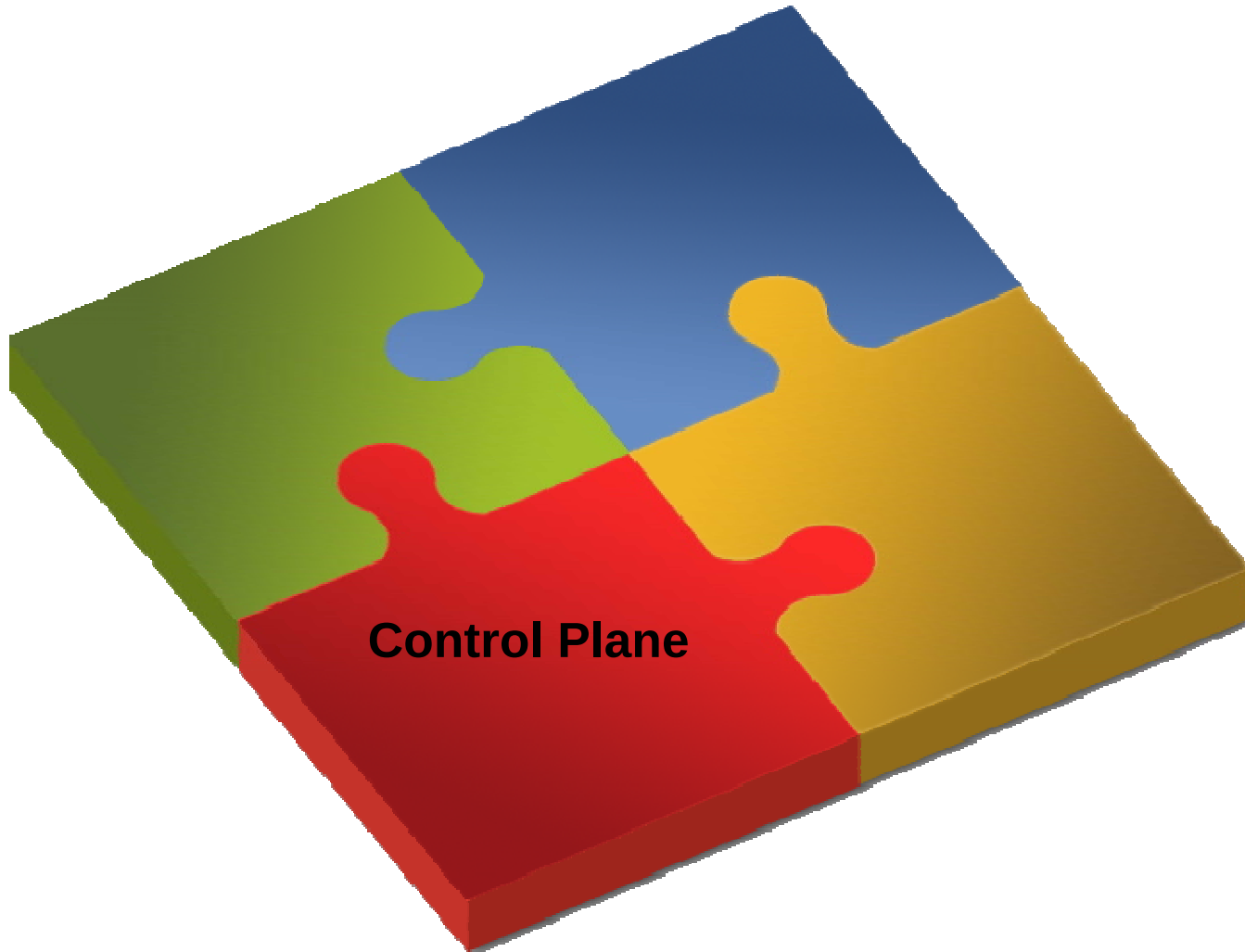
Multi-Degree Colorless Mux and Demux WSS Node



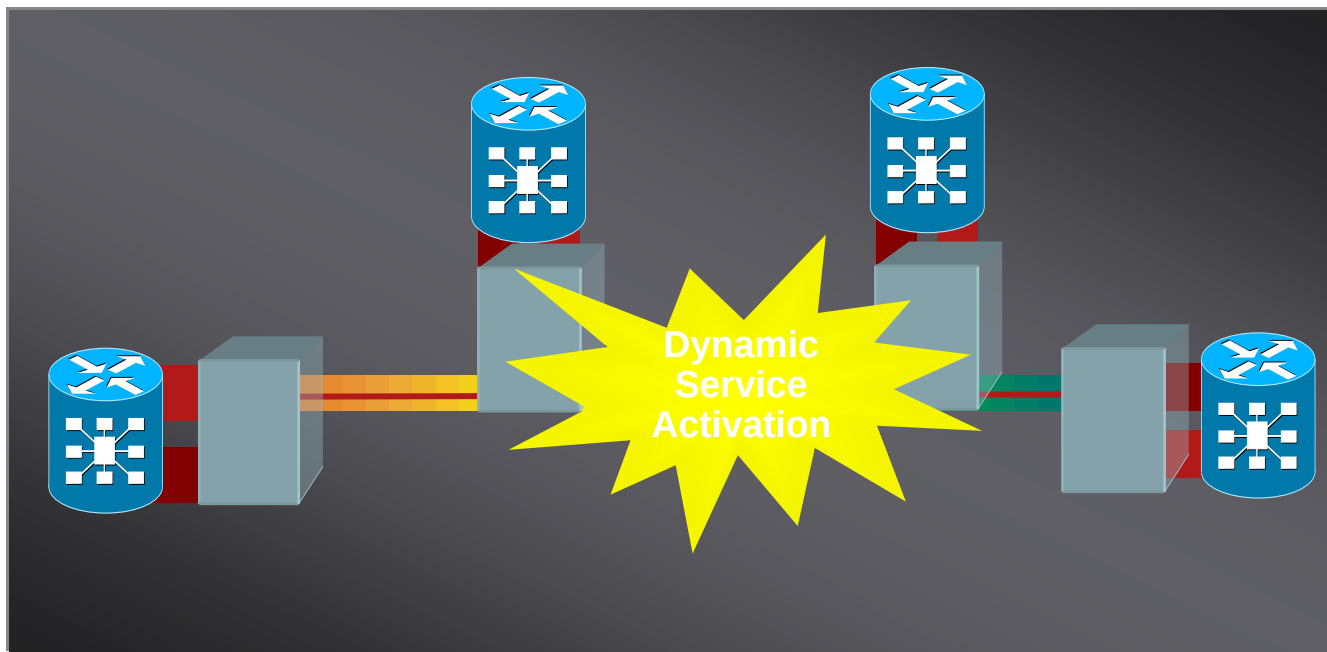
Colorless Considerations

1. Maximum # of Colorless Ports in 2009 = 8
2. >8 Ports Requires Cascading of 9x1 WSS
3. Suppliers are working on High-Port Count Colorless ROADMs (2010-2011)
4. Most Providers will combine Colorless and Colored ROADMs

Putting the Pieces of the Zero-Touch DWDM Network Together



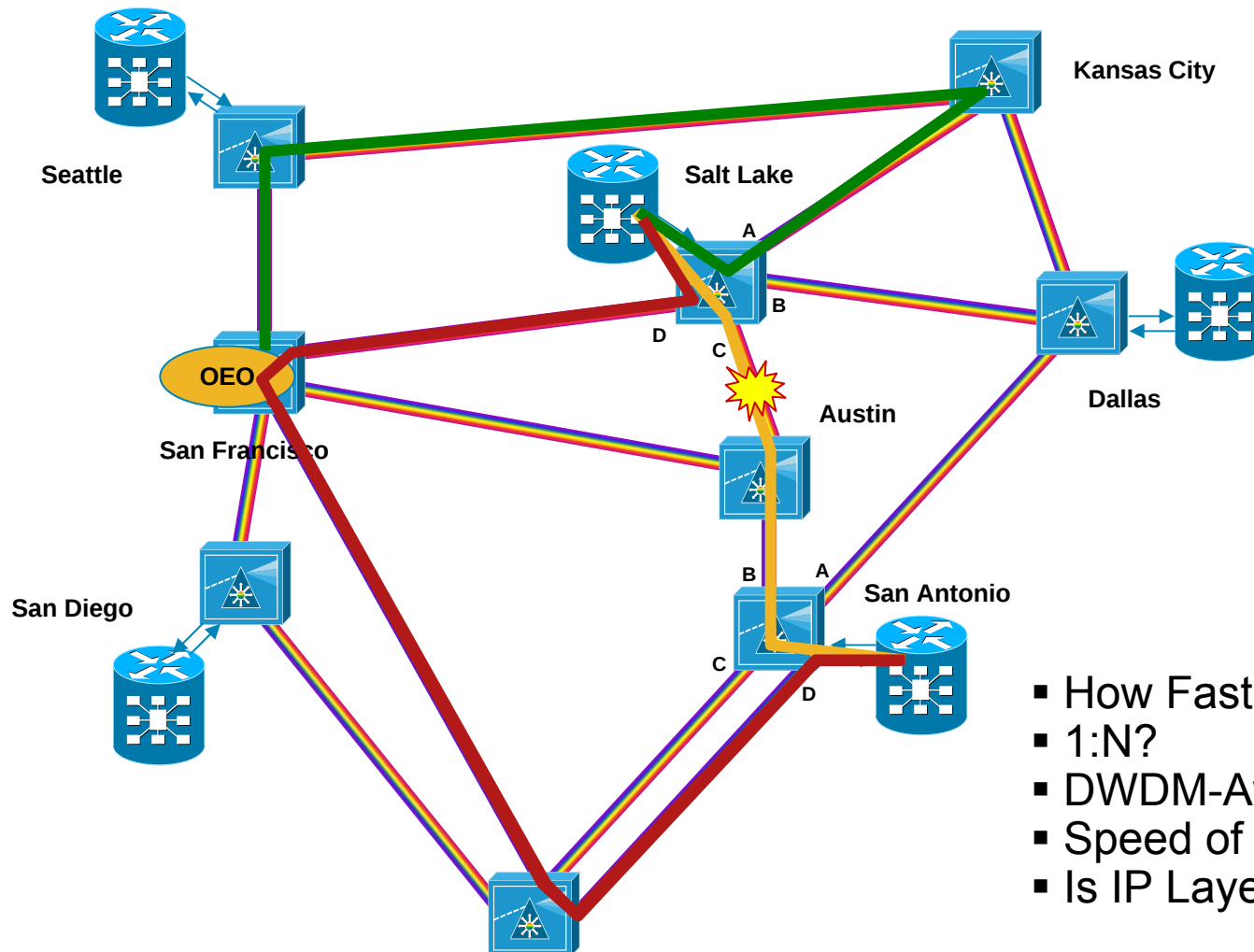
Photonic Control Plane



Dynamic Service Activation with GMPLS

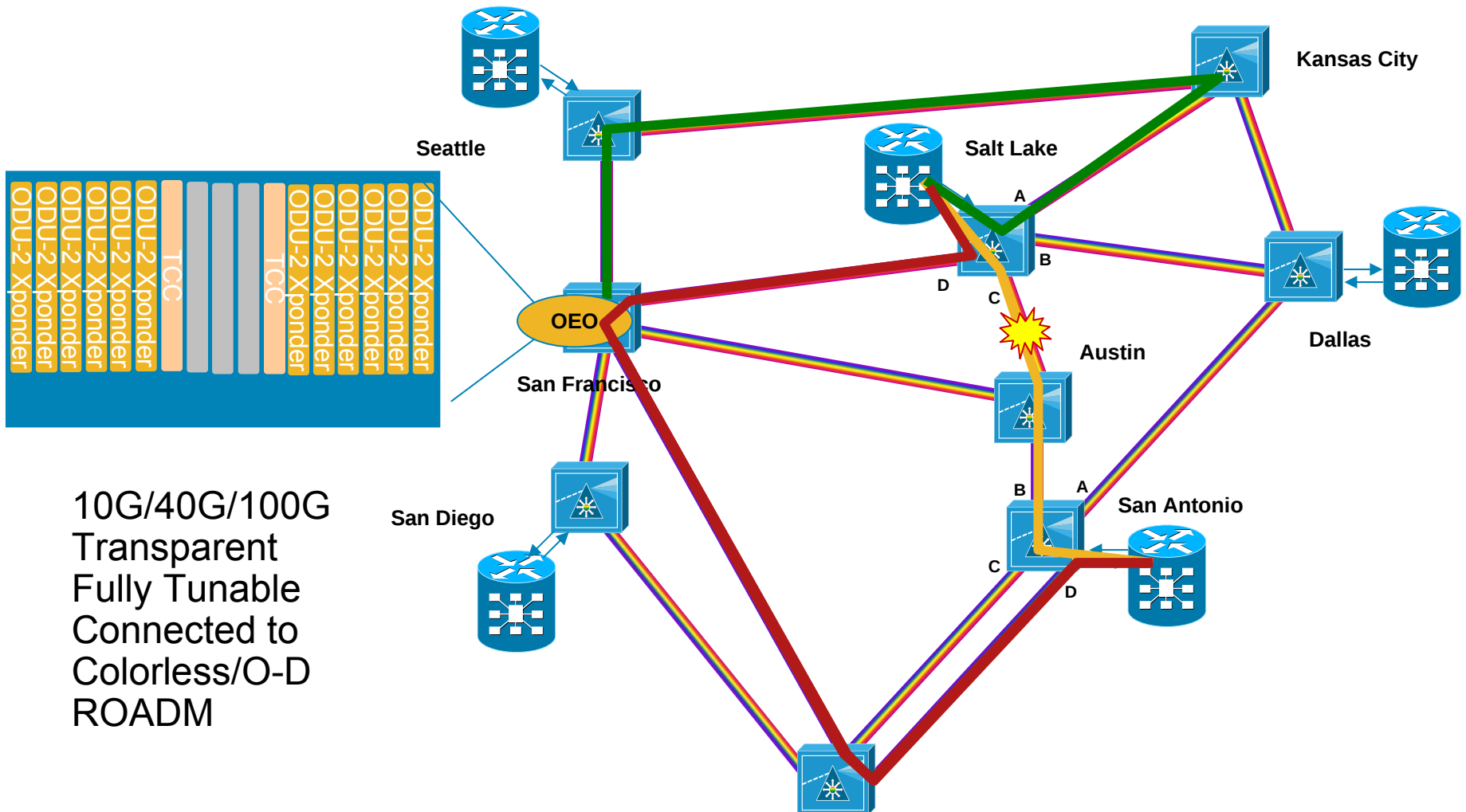
- Auto provisioning on demand via GMPLS
- Supports IPoDWDM and Transponders
- Calculates Photonic Path (Linear and NLE, Amp NF, and CD)
- Auto patching via Colorless/Omni-Directional ROADMs
- Coordinates SRLG with Layer 3 and Layer 1
- No truck rolls for Service Creation or Maintenance

Optical Mesh Restoration



- How Fast?
- 1:N?
- DWDM-Aware
- Speed of Tunable Optics
- Is IP Layer Aware?

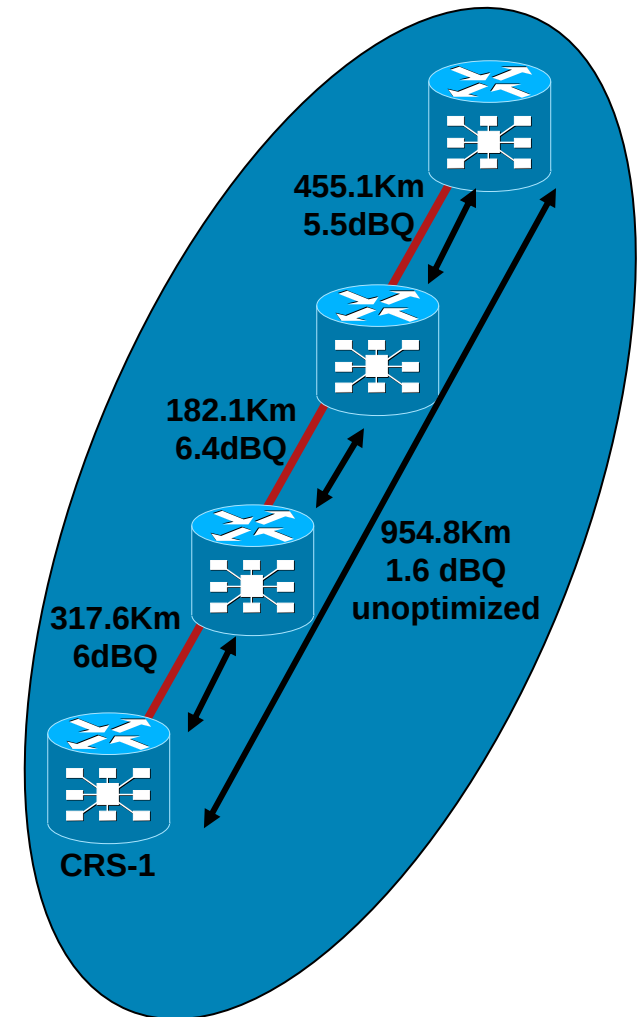
Strategically Placed OEO



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First and Longest IPoDWDM Deployed Customer Application



CRS-1 w/ Integrated 40Gig DWDM Optics

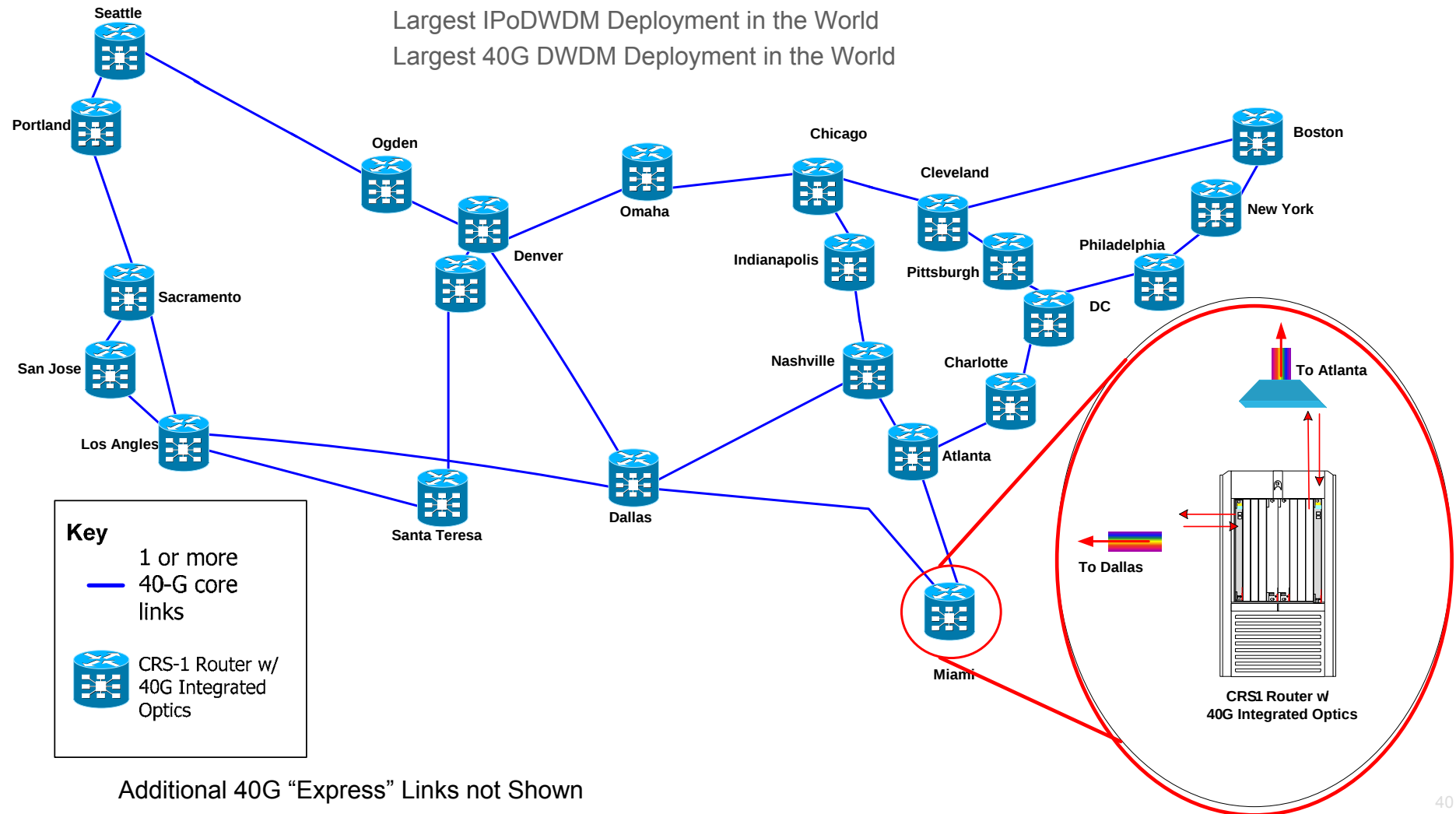
Network Architecture

First 40G IPoDWDM Network in the World

This North American National Network is Currently:

Largest IPoDWDM Deployment in the World

Largest 40G DWDM Deployment in the World



IPoDWDM Momentum

Increasing Customer Success

free

Free (ISP), France

10GE IPoDWDM on CRS-1 over legacy Huawei DWDM for Internet and IPTV



Comcast Cable, USA

Largest IPoDWDM, 40G global deployment
Triple-play services core backbone
Interoperating with **Nortel** DWDM
100G piloted



TeliaSonera, Sweden

World's largest gaming festival with 40G
IPoDWDM on CRS-1

http://www.world-television.se/world_television.se/mnr_stat/mnr/TeliaSonera/294/



Netia, Poland

Compared capex & opex of various solutions with IPoDWDM. Also ease of integration with existing non-Cisco optical gear.



Sprint, USA

Converging all types of business apps (voice, video, data) on a flexible 40G IPoDWDM core network interoperating with **Ciena** optical system



CESNET2, Czech

Using IPoDWDM to reduce points of failure for extreme bandwidth demanding apps
CRS-1 and ONS 15454 MSTP



T-Com, Germany

Using IPoDWDM to cost-effectively increase throughput of existing fiber for IPTV/video services

6 of top 20 SPs globally
Over 20 customers worldwide
40% of 40G ports shipped are IPoDWDM

IPoDWDM

Further Info

Video

Benefits of IPoDWDM:

http://www.cisco.com/en/US/solutions/ns341/ns525/ns537/benefits_of_ipodwdm_ps5763_Products_Brochure.html

Proactive Protection with IPoDWDM: <http://www.cisco.com/go/IPoDWDM>

Website

IPoDWDM- <http://www.cisco.com/go/IPoDWDM>

Press Releases

Free - http://newsroom.cisco.com/dlls/2009/prod_052909e.html

Netia - http://newsroom.cisco.com/dlls/2009/prod_040809.html

Hellas Online - http://newsroom.cisco.com/dlls/2009/prod_022309c.html

CESNET- <http://www.ces.net/doc/press/2008/pr081218.html>

Kyivstar- http://newsroom.cisco.com/dlls/2008/prod_102208.html

National Lambda Rail- <http://www.nlr.net/release.php?id=34>

Comcast- http://newsroom.cisco.com/dlls/2005/prod_120505b.html,
http://newsroom.cisco.com/dlls/2008/prod_062608c.html

Dreamhack- http://blogs.cisco.com/sp/comments/the_gaming_explosion/

Sprint- http://newsroom.cisco.com/dlls/2008/prod_071508b.html

DT- http://newsroom.cisco.com/dlls/2006/prod_120406d.html

Breakout Session Evaluation Form

Your session feedback is valuable

Please take the time to complete the breakout evaluation form and hand it to the member of staff by the door on your way out

Thank you!

